Chemistry I: Refinement of the Atom Model & Electron Configuration

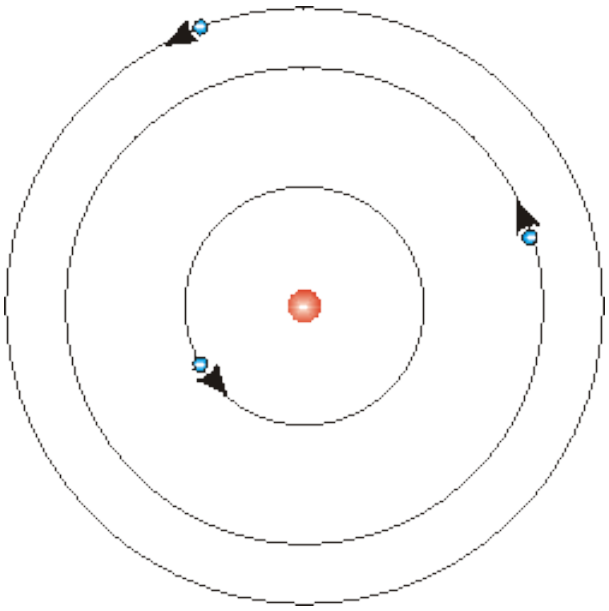
The Electron Cloud

- What do we know about the electron cloud?
  - It contains the subatomic particles called _____
  - This area accounts for most of the _____
  - These electrons have _____
  - Finding electrons in the cloud is _____

Bohr's Model of the Atom

- Bohr pictured the atom as having electrons in _____
- when electrons are in orbits, _____
- total energy of an electron increases as _____

_____



What happens when electrons move?

- energy is _____

_____

– This energy is called _____

– It comes in various forms from _____

- Electromagnetic energy
  - defined as _____
    _____
  - speed in a vacuum is 3 X 10^8 m/s
  - The measurable properties are:
    - Wavelength -_____
      _____
    - frequency- _____
      _____

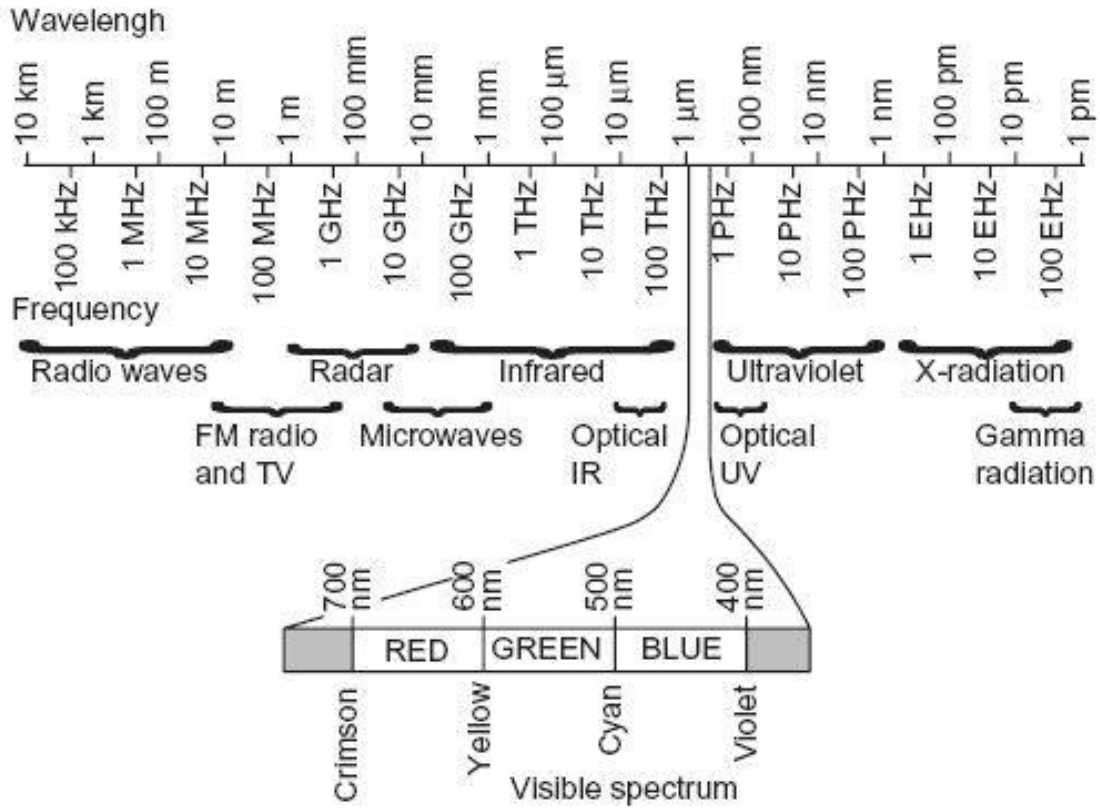
- The math relationship between frequency and wavelength is:
  - $c = \lambda f$
  - where c is the speed of light,
  - λ is the wavelength
  - *f* is the frequency
  - a closer look at this equation reveals _____
    _____

  - other relationships are:
    - wavelength is _____proportional to the frequency

- as the ***wavelength*** of electromagnetic energy **decreases,** the ***frequency increases***.
- also as the ***wavelength*** of the energy ***increases***, the ***frequency decreases.***

– short wavelengths have high frequencies

– long wavelength have low frequencies



– visible light is what you can see

– light with long wave and low energy will appear the color_____

– light with long wave and low energy will appear the color _____

New ideas about energy:

- In 1900, German Physicist Max Planck proposed that the energy comes in _____

  _____

  _____

- Planck called these chunks of energy _____
- a quantum is _____

  _____

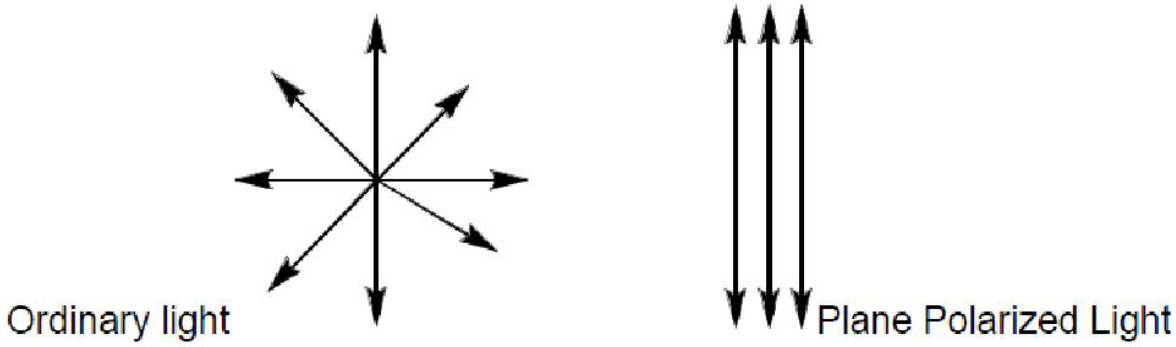
- a _____is a quantum of light
- This leads to a second equation(Planck's equation)
- $E = hf$ where E is energy, h is called Planck's constant which is 6.26 X 10^{-34} joule-seconds

  and f is the frequency
- this means that **energy** is _____
- and when _____increases so does the energy of the radiation

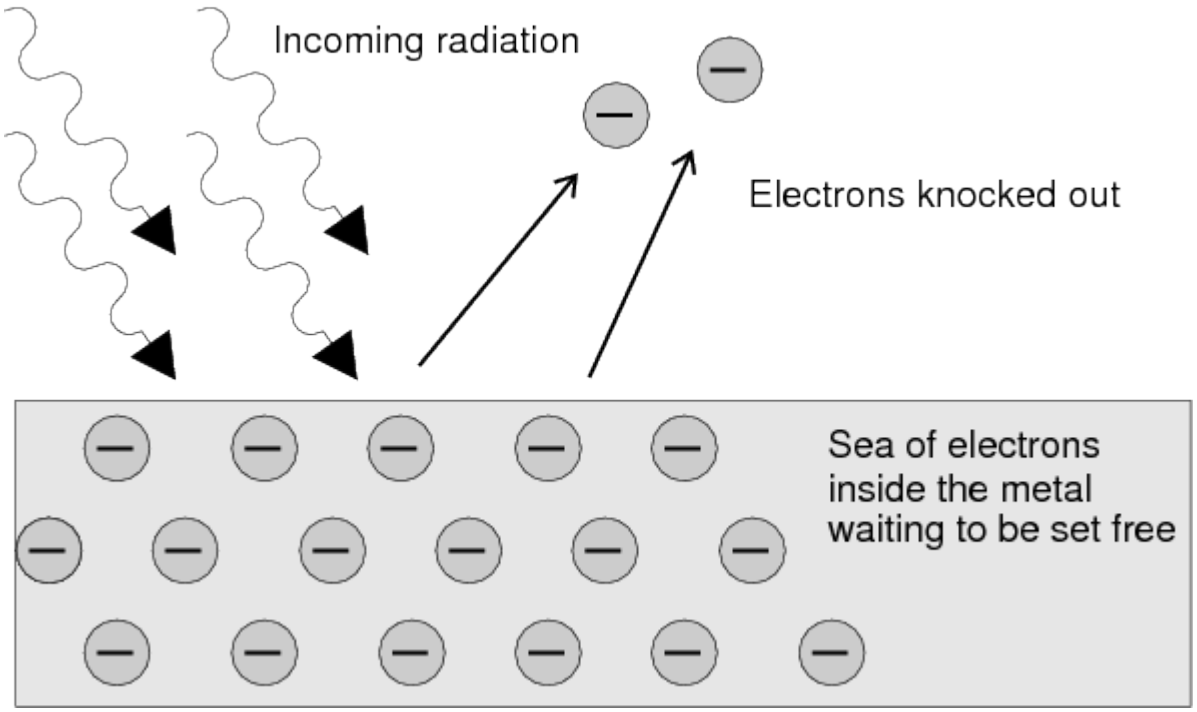
Dual Nature of Light

- Up to now scientists thought that light always acted like a wave.
- But it turns out that some frequencies can act like particles.
- This phenomenon is called the _____
- proof of light acting like a wave is found in _____

Example: polarized sunglasses only let light waves in a single direction through the material.



- Proof that light acts as a particle is found in the photoelectric affect which occurs when light strikes certain metals and _____are knocked out (usually violet light).
- This was explained by Einstein.



What you see

- The human eye can only detect a small region of the electromagnetic spectrum.
- This is called the _____
- We will use this area of the EMR spectrum to identify elements.

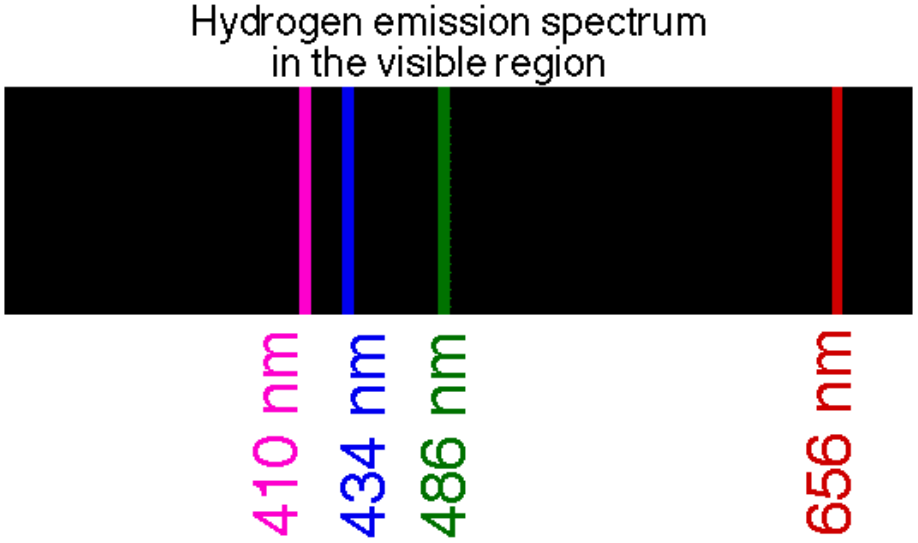
Bohr's Model explains energy release

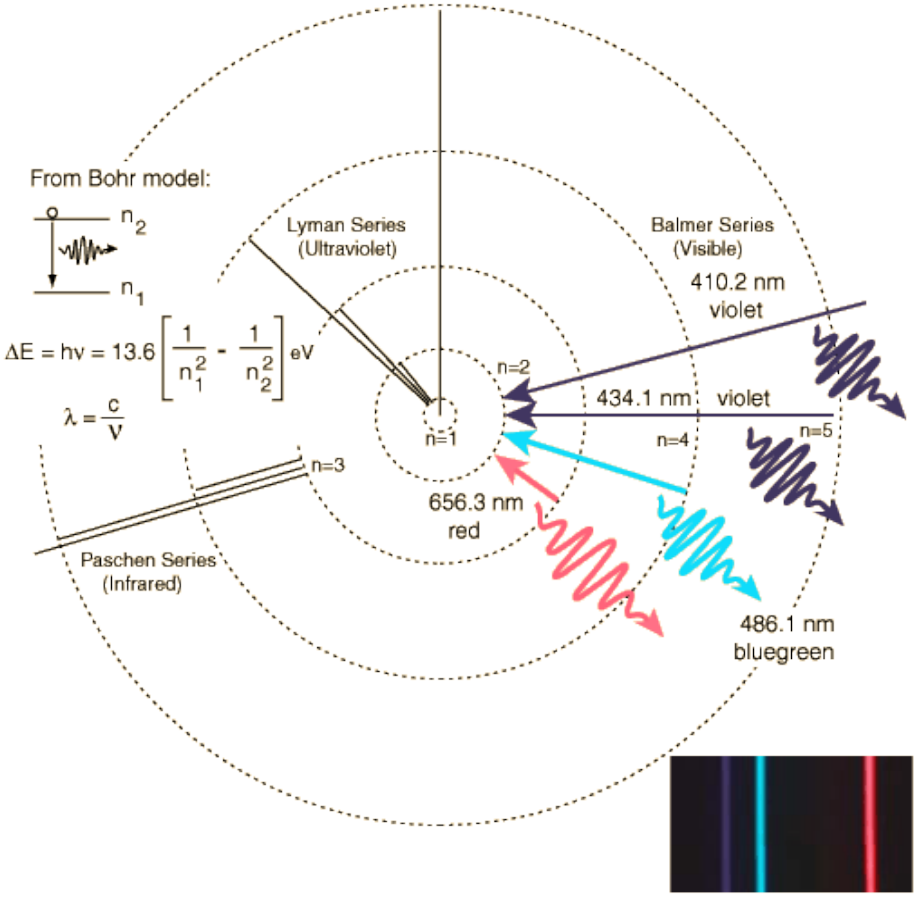
- various electron orbits can be compared to rungs on a ladder.
  - an electron is in _____
  - highest energy level occurs when electron is _____
  - the energy electrons have is a_____
  - math –change in energy- $\Delta E = E_1 - E_n$ where n is the number of an orbit(2,3,4.....)

How Bohr explained spectra

- Bohr explained the small bright spectral lines came from _____

  _____



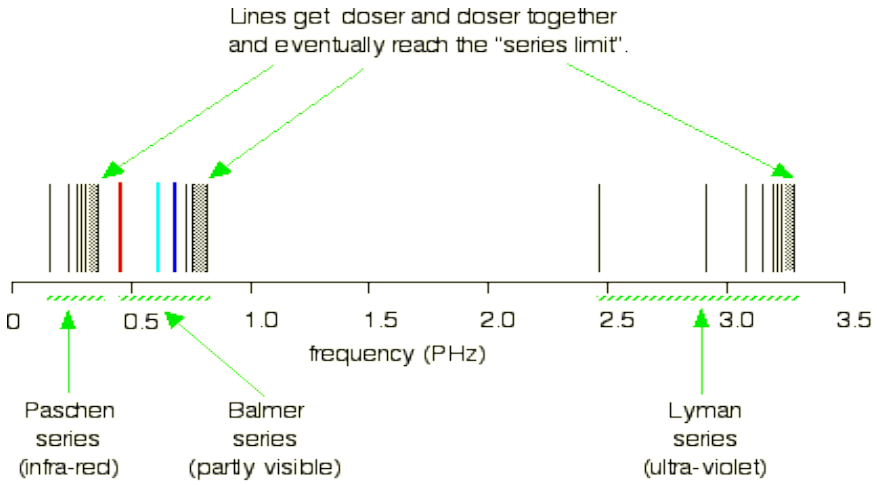


Support for Bohr

- J.J. Balmer had developed a mathematical formula to support Bohr's idea.

Bohr could not explain some of the spectral lines we cannot see.

- These were in the infrared and ultraviolet regions of the EMR which we as humans cannot see.



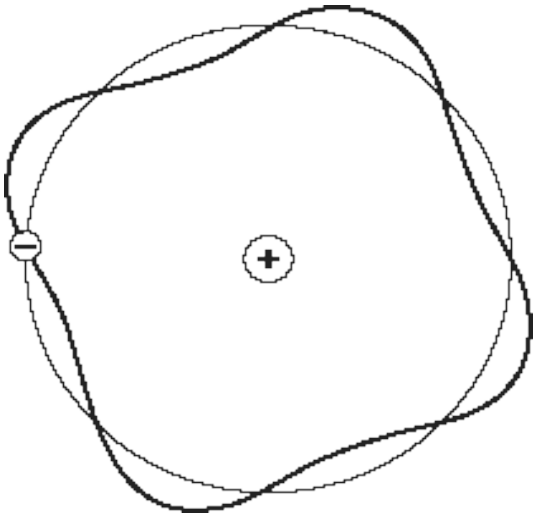
Bohr adds the quantum idea

- Bohr reasoned that the energy coming from electrons moving down from higher levels to lower levels in an atom were:
  - Going from _____
  - Releasing energy _____

New Ideas about the Electron

- de Broglie reasoned if light acts like a wave, _____

  _____
- this was consistent with Bohr's proposed _____
- This is how de Broglie saw the electron wave



Quantum Model of the Atom

1. The location of the electron _____
   - This brings us to the Heisenberg Uncertainty Principle that states _____

     _____

     _____

2. The electrons are in energy levels.

– As the levels increase in energy _____

– In other words; electrons with more energy are_____

– The energy levels are also known as_____.

3. The mathematics describes for us a region of space _____

_____

These are 3-D regions that are called _____ or Atomic orbitals exact.

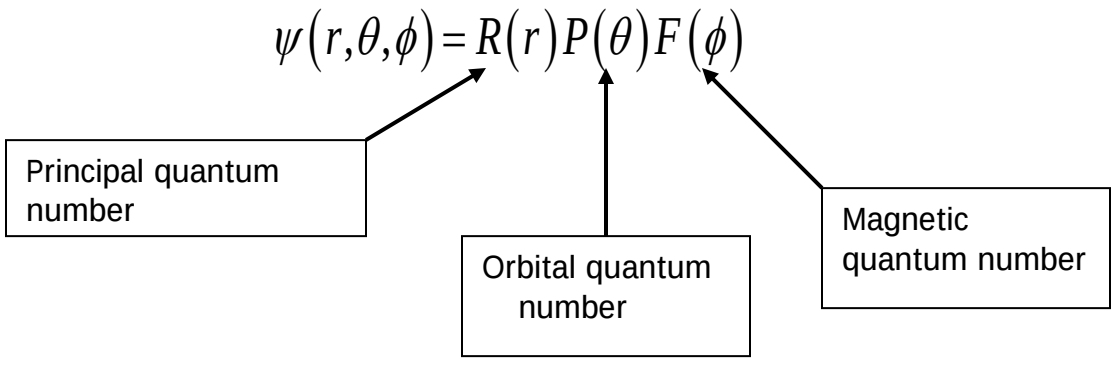
The Schrødinger Equation is the fundamental equation of quantum physics and can be expressed as follows:

$$H\psi = E\psi$$

This is a huge equation when all the stuff is put in:

•

–For the hydrogen atom (1 e^{-1}) the answer looks like this:



Quantum Model of the Atom

- 4. The math equations describe electrons in what is known_____

  there are four number

- a. Principal Quantum (n) number indicates _____

  and n = 1,2,3,4,5,6,7....

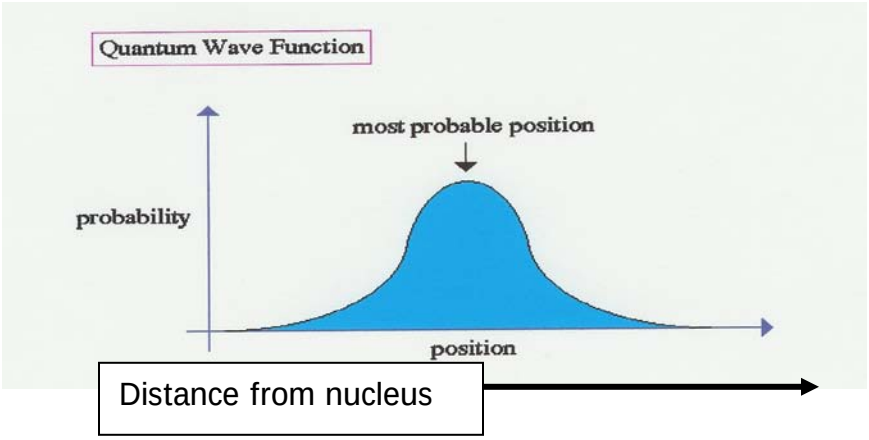
- b. Orbital quantum number (l) identifies _____
  - 1 0 = s orbital 3. 2 = d orbital
  - 2. 1= p orbital 4. 3 = f orbital
- c. Magnetic quantum number(m) _____

_____

- d. Spin quantum number (s) shows the spin (rotation) of the electron_____

  Has only two possible values + ½ or – ½.

Where an electron might be found

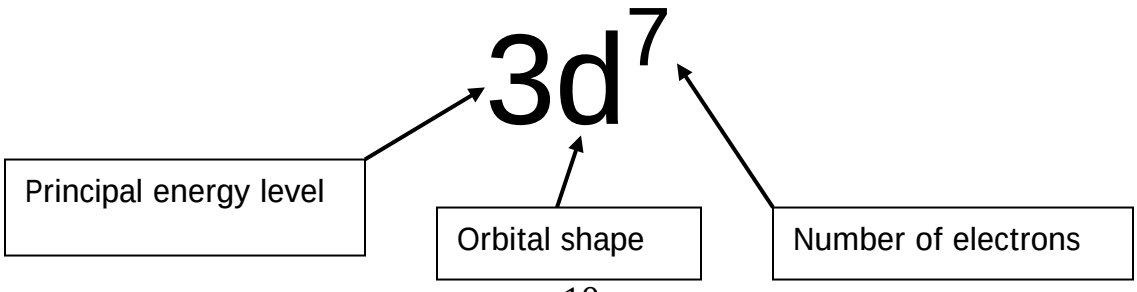


Electron Configuration

- Assigning electron configuration is assigning addresses to electrons according to ____

  _____

- There are 3 ways to show electron addresses:
  - 1) electron configuration- shows principal energy level, orbital shape, & # of electrons
    - Example: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$



- 2) orbital notation –uses arrows and lines to show electrons usually in the outermost electron orbitals
  - Example: ↑↓ ↑↓ ↑↓ ↑

- 3) dot notation (also called Lewis dot)-uses the symbol of the element and dots to show the the outermost electrons.
  - Example: •H

Electron Configuration Rules

- From quantum mechanics we have a probable location of the electrons in an atom.
- The four quantum numbers describe an electron.
  - The **Pauli Exclusion Principle** says _____

    _____
  - This means that they cannot be in the exact _____

Location of electrons

- Now, where are they?
  - Well we know that they are in regions called _____
  - These 3-D regions of space are _____
  - Any one suborbital can only hold 2 electrons.
  - also know that the orbitals have shapes and are oriented around the X, Y, and Z-axis.

Suborbitals

- Atomic orbitals are subdivided into suborbitals. This is how it looks:

orbitals	suborbitals	total# electrons	Shape
s	None	2	sphere
p	3	6	dumbbell
d	5	10	multiple
f	7	14	Don't go there
g	9	18	Too complex
h	11	22	No clue

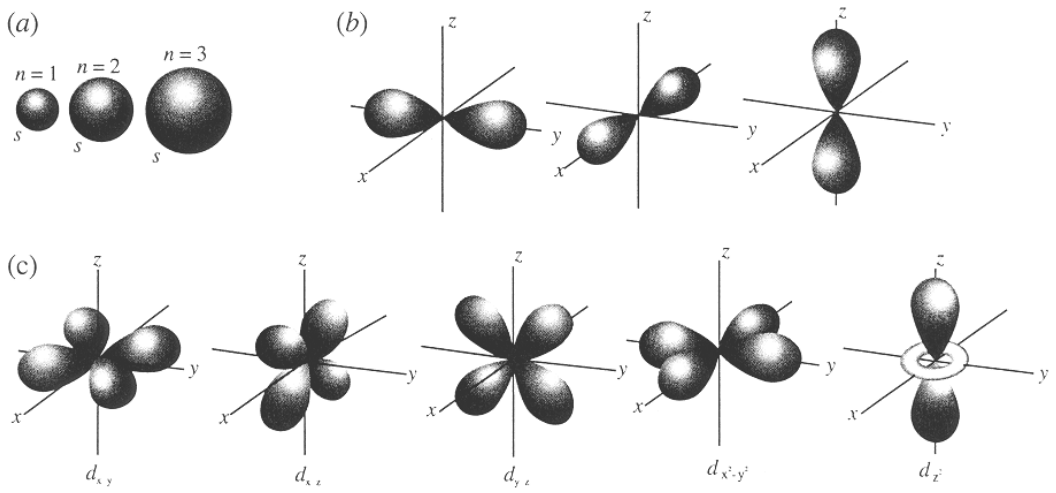


Figure 3.1 Geometry of orbitals in the *s*, *p*, and *d* subshells. Orbitals represent the volume of space around a nucleus in which an electron is most probably located. (*a*) Orbitals in the *s* subshells are spherical in all shells. (*b*) The *p* subshell contains three different bilobate orbitals oriented along orthogonal *x*, *y*, and *z* axes. (*c*) The *d* subshell contains five orbitals. The d_{xy}, d_{xz}, and d_{yz} orbitals are quadralobate and lie in the *xy*, *xz*, and *yz* planes, respectively, so as to bisect the angles between the orthogonal axes. The $d_{x^2-y^2}$ orbital forms a quadralobate shape with lobes aligned along the *x* and *y* axes. The d_{z^2} orbital forms a torus with a bilobate shape aligned along the *z* axis.

- **Aufbau principle**
- When electrons are_____

  _____
- . You cannot add outside in.
- **Hund's rule**
  - Orbitals of equal energy are _____

    _____

    _____
  - Explanation: when putting electrons in the p-orbitals there must be one electron in p_x, p_y and p_z before any of the others can have get a second electron.

Following the flow chart

- When writing electron configuration you will need to follow the order of fill chart.
- This is a systematic way of arranging the electrons.
- You will need to know how many electrons are in each of the orbitals.

– The configuration you write may not match what is in Chemistry textbooks because electrons in more complex atoms will move to create more stable configurations based on the lowest possible energy.
– Remember that the most stable electron configuration is that of the noble gases which all have_____.